BIOLOGY AND COSMONAUTICS

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Sisakyan, N.M. (Academy of Sciences USSR, Moscow). Biology and Cosmonautics. An introductory speech at a meeting on bioastronautics and space medicine. A general outline is given of the papers presented, and important points of further research are given, with main emphasis on physiological and psychological effects on the human organism of weightlessness, radiation damage, accumulation of anthropotoxins, etc. Publication of an international abstract journal, exchange of scientific information, and coordination of research are suggested.

Ladies and Gentlemen, Honored Colleagues:

All of us are enjoying the heart-warming hospitality of a country whose people have made altogether outstanding contributions to the development of science and to social and economic progress, and are continuing to make such contributions.

All this makes our meeting here, in the fatherland of the great Nikolaus Copernicus of Torun, particularly significant, particularly memorable.

We recall what this outstanding scholar wrote in the introduction to his book De revolutionibus orbium coelestium (Of the Revolutions of the Heavenly Spheres):

"Among the numerous and varied occupations with the sciences and arts that engage the human mind, I affirm that in the very first place men should give themselves up to, and devote their greatest effort to, those concerning the

* Numbers in the margin indicate pagination in the original foreign text.

subjects that are the most beautiful and most worthy of knowledge.

"Such are the sciences studying the divine revolutions of the universe, the courses of the luminaries, their size and distance, their rising and setting, together with the causes of the other heavenly phenomena, and which, finally, explain the whole aspect of the Universe" (Copernicus, Russian translation, "On the Revolutions of the Heavenly Spheres", Introduction, Book One, p.16. Edition "Nauka", USSR Academy of Sciences, 1964).

The time that has passed since those lines were written has not passed p.2 in vain for humanity.

To the lot of all of us has fallen the good fortune of being witness to Man's achievement of lifting himself towards the stars, of gazing more widely on the universe that surrounds us, of attaining more profound understanding of Man's own nature.

Astronautics today is a clearly defined field of practical activity, unceasingly drawing into the orbit of its own interests ever new spheres of science and industry.

It is therefore only natural that the very first steps of astronautical practice should be closely associated with biology - with bioastronautics and space medicine.

The thought arises of itself that perhaps it was not altogether by chance that Copernicus was a graduate of a medical school and a practicing physician, that Galileo had a medical education, and that Lomonosov was interested in biological problems, like many other great scientists of his time who distinguished themselves as investigators into the Universe.

Universal and life! These two concepts, so intimately interrelated, might perhaps be said very logically and naturally to define the relation

between biology and astronautics.

But as we recall the past and turn our eyes towards the future, we must still be clearly aware that the frontiers that have now been crossed, important though they be, are but the first barriers.

There are probably not so many cases to be found in History when contemporaries of an event were given the power of fully apprehending it. It was far more often impossible to determine all the significance and possible consequences of results that had been achieved. p.3

In this respect we are indeed fortunate.

It is our object today carefully and critically to review our acconplishments in the fundamental fields of bioastronautics and to chart the paths for further advances.

Among the many important consequences of the successful development of astronautics, it is important to emphasize at least the following:

First, new conceptions of the place of Man in the Universe are being defined, ever more clearly. We have been enabled to view life and view Man, in a manner of speaking, from the cosmic point of view. The advances of astronautics have brought us very close to the study of the paths, character and rates of evolution of organic matter in the Universe, and, further than that, promise to enable us to conduct direct experimental studies of the fundamental laws of the life process, a subject of extreme importance to the general progress of Science and of its possible practical applications (aspects).

The realization of the immensity of the problems that confront Science in studying and mastering Space might be said to focus our thought, with particular urgency, on the significance of this problem for all mankind, on the need of combining the efforts of the scientists of different countries.

In this connection we may note with great satisfaction that the Moscow Agreement on the prohibition of nuclear tests in three environments, and - what is of particular significance for us - in space as well, opens up the way to further expansion of cooperation between scientists and to the strengthening of the international relations between them. Previous discussions have clearly shown us, once again, how very greatly the progress of civilization depends on the preservation and strengthening of peace. p.4

Secondly, another important consequence of the development of astronautics has been its extremely powerful stimulus on scientific research, on the incorporation of new principles and ideas, in the most varied fields of knowledge, including biology.

It is sufficient merely to mention that the achievements registered in the development of the principles and methods of establishing closed ecological systems for space ships are opening up extensive opportunities for their utilization in the food industry, agriculture, and the like. This is of particular importance today, when no small part of the human race is still in need of food supplies.

Thus present-day biological engineering, which owes its inception to the demands of astronautics, also promises to aid in solving many other vital problems.

And, thirdly, space medicine is still another important consequence of astronautics, which has given birth to the whole group of space sciences. Particularly is this expressed in the aid given today by space medicine to the progress of general clinical medicine and public health work. We recall the practical adoption of new methods of functional diagnosis, principles of occupational selection, the birth of new ideas in connection with the study of

the reactions of the organism to extreme environmental factors, which is so essential for the better understanding of the pathogenesis of a number of dis- p.5
eases and their rational treatment. Mathematical methods of investigation are gaining ever wider acceptance, together with the application of the computer, which promises to solve many heretofore impenetrably difficult problems of continuous control of the condition of critical patients, the introduction of methods of providing first aid, including automatic processes, and the like.

The significance of astronautics for the development of science, technology, industry, art, and many other fields of human endeavor could be illustrated by a multitude of examples.

But what I have already said is probably enough to authorize the conclusion that the development of the space sciences, including bioastronautics, not only serves the primary purpose, namely the study of space, but also, in turn, is helping to solve many "terrestrial" problems, and, in general, is assisting the overall progress of civilization.

The experience of the few past years indicates that biologists were sufficiently trained to meet the practical needs of astronautics, and that a certain scarcity of information on several important problems has been removed by profound and purposeful research performed in an atmosphere of creative enthusiasm by large groups of specialists.

The results have been the realization of a rather extensive program of laboratory, test-stand, and flight experiments, including rocket and space-ship flights, which finally made it possible for Man to fly in space.

Yuriy Gagarin, and the Soviet and American cosmonauts who followed him, p.6
consolidated the achievements of bioastronautics and opened up wide new possibilities for space study. We are now no longer confined to the use of auto-

matic space instruments for our research, but can utilize, ever more extensively, the human investigator, which is the peculiar feature of the present stage of development of bioastronautics.

It must be said that we know enough today to be aware of the basic obstacles and difficulties that stand in the way of the further penetration of Mankind into space.

And this is most important, since it permits us to concentrate our efforts on solving the most essential and primary problems.

Thus, for example, weightlessness continues to be one of such problems in space physiology. It is closely connected in some of its aspects with physiological accelerations, so much so that today it is ever more clearly denominated a special field of research, that of gravitational biology. Here investigators expect to engage in fascinating searches for the general biological laws that determine the reactions of the organism to the gravitational factor, and studies of extreme interest in justifying and designing artificial gravity systems for those interested primarily in applied problems.

All this is so important for our advance that the Program Committee of this Congress quite properly devoted a special session to it.

The problem of reactivity, and the mechanisms of adaptation and development of compensatory reactions by the organism should, with full justification, be the focal points of our attention, since the utilization and improvement of the natural resources of the organism itself are the most promising ways for enhancing its resistance to the action of unfavorable environmental factors. Closely connected with this problem are a large number of problems of independent importance, such as training, use of the bountiful resources of pharmacology, design of protective equipment, rockets, and the like. p.7

The papers already read at this Session have touched on these important problems.

One of the central problems of bioastronautics is the development of means and methods of assuring the life processes of space-ship crews during long voyages. Provision of an artificial atmosphere in the cabin, determination of the allowable limits of fluctuation of specified parameters, elucidation of the role and course of the accumulation of anthropotoxins, of the significance of the microflora and the possibility of controlling it, of the changes in the immune properties of the organism, and of a number of important problems of mental hygiene - to name these is merely very generally to note, without exhausting the list, the scientific problems that must be solved before long space voyages can actually be made.

We shall have an opportunity to acquaint ourselves with the results of studies in this direction, and some papers will also touch another, but closely related, problem, that of designing closed ecological systems for p.8 space ships, a problem which in the fullest sense of the word is a "touch stone", not only for biology but for science as a whole. The results attained may be expected to have far-reaching consequences, both for theory and for many fields of practical activity.

It would evidently be useful to discuss questions of this kind with the participation of designers and scientists alike. Both are necessary for any comprehensive survey of the problem.

The mastering of nuclear energy gave rise to radiobiology and led to its present status. Bioastronautics must be relied upon in evaluating the radiation situation and the question of safety in space flight.

There are still, however, substantial lacunae in our knowledge of the

character and peculiarities of the biological action of certain components of cosmic rays, especially with respect to the effects of heavy nuclei, the effect of radiation in combination with other factors of flight, and several other questions. For prolonged voyages, especially in view of the variability of the radiation environment, the protection of cosmonauts against radiation damage acquires a very high priority indeed.

Speaking of prolonged flights, we must not forget the important physio- p.9
logical aspects associated with them. These problems are still far from solution. There can and should be differences of opinion as to just how important they really are. Possibly, today we may even be somewhat overestimating the importance of the peculiar psychological conditions of the artificial environment of the space ship, the isolation of the crew and the problem of compatibility. Obviously, however, all the questions in this category demand serious experimental study.

Deserving of special mention is the group of studies on problems connected with the control of the space vehicle, the connections between its individual components, and maintenance of the necessary level of working fitness of the crew members. Some of these questions will be elucidated in the papers to be presented to you.

The program of the forthcoming discussions does not, of course, touch on all important departments of bioastronautics. Far from it! For example, departments as important as exo-biology, systems of maintaining life on space ships, the problem of special training for the crew, and many others, have been completely omitted. This is not at all surprising, for the range of interests of bioastronautics today has become so broad that any complete discussion of the basic problems could constitute the theme for the entire Congress.

I cannot fail to note that the Program Committee and Prof. Sommerfeld, Prof. Lunz and Dr. E. Konesi, have done everything possible to make our sessions as representative as possible. It is enough to say that, thanks to p.10 their kind cooperation, the number of sessions, and consequently also the number of papers presented, was doubled.

Permit me, on your behalf, to express our profound appreciation to the members of the Organizing Committee.

Trends of development of modern science, especially in its applied branches, are such as to compel us to direct our attention, as well, to certain general organizational problems, chief among which are the planning and coordination of research and the exchange of scientific information.

It would be extremely desirable to take advantage of this meeting to chart the paths toward solution not only of the scientific problems but also of the organizational ones, to plan, so to say, the general lines of scientific strategy and tactics that would ensure the most effective development of bioastronautics.

Some thought should be given to the publication of an abstract journal on an international basis, which would be a fundamental work summing up the results of the achievements of bioastronautics; and to planning the programs preceding scientific discussions; and to other measures that would promote the progress of our cause and strengthen our cooperation.

Permit me to express the hope that the present Congress will be a substantial contribution to the development of bioastronautics, and to wish you successful work.

I thank you for your attention.